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WATER QUALITY MONITORING NORTHWESTERN ONTARIO, 1976

March 1978

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WATER QUALITY MONITORING

NORTHWESTERN ONTARIO, 1976

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INTRODUCTION

Although there are a vast number of pristine lakes and rivers in Northern Ontario, demands by industry and population have resulted in areas of degraded water quality. In 1968, monthly water quality monitoring was initiated by predecessor agencies of the Ministry of the Environment in many of these localized areas (Figure 1) to obtain basic physical, bacteriological and chemical data. Data obtained from this program are used to evaluate the need for and/or the effectiveness of abatement programs and to assess any limitations on the use of the receiving waters.

Dissolved oxygen concentrations and temperature readings were obtained in the field. Bacteriological and chemical analyses were conducted at the Ministry of the Environment Laboratory in Thunder Bay. When the microbiological sampling frequency did not meet Ministry specifications for determining water quality for domestic and recreational use, several years data were reviewed before conclusions were drawn. The results for sampling stations in the vicinity of major population centres in northwestern Ontario are discussed under appropriate headings. Although this report is based primarily on water quality data obtained in 1976, observations and analytical data from past Ministry of the Environment surveys are also used where appropriate.

SUMMARY

THUNDER BAY

Portions of local rivers and the near-shore Lake Superior waters adjacent to the City of Thunder Bay have been contaminated by industrial and municipal discharges. The Kaministiquia River, downstream from the Great Lakes Paper Company Ltd., is the most seriously affected area. Adverse water quality characteristics

include depressed dissolved oxygen concentrations, elevated bacterial levels and nutrient enrichment. Summer dissolved oxygen levels at many river sampling stations are frequently below the criterion established to protect warm water fisheries and other desirable aquatic life. Microbiological results indicate that these waters are unfit for public water supplies or body contact recreation. Of the nutrient parameters, phosphorus warrants most concern. As phosphorus is considered the growth limiting nutrient in these waters, elevated concentrations are conducive to generally undesirable aquatic growth. There is also a noticeable aesthetic loss: waters are discoloured, malodourous, and occasionally covered by small oil slicks.

Conditions of near-shore Lake Superior waters in the Thunder Bay area are much better in comparison to the lower Kaministiquia River; however, impairment of the inner harbour and adjacent outer-harbour areas is evident. Elevated microbiological and nutrient levels are found in Lake Superior. Bacterial counts at all stations during the summer months frequently exceed Ministry of the Environment criteria for swimming, and related activities. The increase in nutrient concentrations has probably caused the emergence in recent years of generally undesirable aquatic growth. For example, cladophora growths (a potentially nuisance alga) have been reported in some sections of Thunder Bay.

Local rivers flowing through Thunder Bay exhibit varying degrees of contamination. Most seriously impaired are the lower sections of the McIntyre and Neebing Rivers, which are affected by municipal wastes. These waters are not suitable for body contact recreational pursuits. The McIntyre River also exhibits depressed dissolved oxygen and elevated ammonia concentrations which are toxic to fish and other aquatic life. A loss of aesthetic value is evident; waters are discoloured and malodourous. During summer months, bacteria counts at stations near the mouths of the Current

River and McVicar Creek exceeded the Ministry of the Environment criteria for body contact recreation.

A program of extensions to the municipal sewer system and expansion of sewage treatment facilities, together with major industrial water pollution abatement programs (particularly at the local pulp and paper mills) is expected to result in significant improvements in water quality in Lake Superior and the rivers in the vicinity of the municipality.

DRYDEN

While most waters in the Dryden area are negligibly affected by municipal and industrial demands, the Wabigoon River has been seriously impaired by the operations of Reed Limited. High bacteria counts and very poor aesthetic conditions limit use of most of this river to the translocation and assimilation of industrial wastes. Toxic conditions have eliminated most fish populations in the river between Dryden and Clay Lake.

Further down the Wabigoon River system, where habitats are favourable to fish, most are unsuitable for human consumption owing to extremely high methyl mercury concentrations present in the fish flesh.

A water pollution control and treatment program, still being implemented by Reed Limited should substantially improve the quality of waters affected by the Company operations. However, the effects of past industrial discharges, particularly of those containing mercury will limit utilization of the Wabigoon River for decades to come.

KENORA

Contamination near the outlet of Lake of the Woods, in the Kenora vicinity, and the Upper Winnipeg River has limited utilization of these waters for domestic and recreational purposes. In Safety Bay, undesirable microbiological conditions are solely responsible for preventing optimum use of these waters. Discharges of domestic wastes from unserviced residential areas in Kenora are believed to be the principal source of the problem. These wastes are expected to be diverted to the expanded sewage treatment plant in the near future.

Wastes entering the Upper Winnipeg River have sharply limited recreational pursuits, domestic use and aesthetic value for several kilometres downstream of Lake of the Woods. Impairment of these waters stems primarily from past and present operations of the Ontario-Minnesota Pulp and Paper Company Limited.

While provision of primary treatment to the mill effluents a few years ago has eliminated the major discharges of suspended particulates (fibre, bark, etc.) which occurred in the past, some materials of this nature are still present in mill effluents. It is expected that improvements in primary treatment to be implemented by the Company over the next few years which will reduce these discharges to acceptable levels and eliminate the balance of the problem resulting from the discharge of such materials.

RAINY RIVER SYSTEM

Industrial discharges to the Rainy River at International Falls and Fort Frances are primarily responsible for limited recreational and domestic use of these waters. Elevated bacteria levels not only exceed the Ministry of the Environment criteria for swimming, and other body contact sports, but also the criteria for public surface water supplies. An aesthetic loss is noted

in some river reaches where suspended particulates inhibit water recreation. It has been reported that some fish collected from the river are impaired with respect to taste and odour.

Additional facilities for primary treatment of its pulp and paper mill effluent are being constructed by the Ontario-Minnesota Pulp and Paper Company Ltd., Fort Frances. These facilities are expected to ensure that suspended particulates in the mill effluents are reduced to acceptable levels.

RED LAKE AREA

With the exception of small watersheds affected by mining operations, waters in the Red Lake area are excellent for public use. In the Balmer Lake watershed, arsenic, cyanide and manganese levels exceed Ministry of the Environment criteria for public surface-water supplies. In addition to industrial contamination, partially treated sewage entering Balmer Creek frequently creates microbiological conditions unsuitable for body-contact recreational use. Waters in the Snib Creek system also have arsenic and manganese concentrations exceeding Ministry of the Environment criteria for potable use.

Water supplies used by various communities in the Red Lake area meet all Ministry criteria.

ASSESSMENT

THUNDER BAY

Lake Superior

Results (Table 1) of monthly samples collected during the ice-free season at stations 8 to 13 (Figure 2) indicate that Lake Superior waters have been impaired by industrial and municipal discharges. Contamination of the inner harbour at stations 8, 10 and 11 is primarily the result of effluents discharged from Abitibi Forest Products Limited (Provincial Paper Division), the municipal sewage treatment plants, Canada Malting Company Limited and Northern Wood Preservers Limited. Parameter values at station 8 are also affected by Kaministiquia River flows. Effects on water quality by effluent from Abitibi Paper Company Limited, Fort William Division, are assessed from samples taken at site 9. Changes in water quality due to operations of Abitibi Forest Products Limited, Thunder Bay Division, are monitored at stations 12 and 13.

Major problems for these Lake Superior waters include elevated bacterial and nutrient levels. Waters receiving pulp and paper mill effluents exhibit the most adverse characteristics. Total coliform bacteria counts at stations 8, 9 and 10 were 3,480, 8,000 and 2,590 per 100 ml, respectively. These levels significantly exceed the Ministry of the Environment criterion of 1,000 counts/100 ml (millilitres) for swimming. Other stations also frequently exceed this criterion during the warmest months, although the geometric mean for the period sampled was less than 1,000 counts/100 ml. Substantial reductions in bacteria counts are expected in the near-shore waters affected by the McIntyre River flow; partially treated sewage discharges which now sharply elevate the bacterial counts in this river will be diverted with all sewage to the expanded sewage treatment plant on Pacific Avenue which is expected to be brought into full operation during 1978.

Nutrients, particularly phosphorus, show elevated concentrations at all sites; most noticeable are total phosphorus levels of .029, .022 and .023 mg/l observed at stations 8, 9 and 10, respectively. Phosphorus levels are above values observed in the uncontaminated near-shore waters of Lake Superior (less than .01 mg/l) and certainly are conducive to the promotion of generally undesirable aquatic growth. Although evidence of increased phytoplankton stocks is inconclusive, the emergence of cladophora growths (a potentially nuisance alga) has been noted in recent years.

Concentrations of organic wastes measured as BOD_5 were moderate at most sites with the highest mean level of 7.0 mg/l being recorded at station 10. Because microbial degradation of these wastes utilizes oxygen from the water column, dissolved oxygen concentrations are depressed at most sites. Dissolved oxygen levels, however, were usually greater than 5.0 mg/l (the level necessary to sustain indigenous game fish populations). The only exceptions occurred in September, when values of 3.9 and 4.3 mg/l were recorded at stations 9 and 10, respectively.

Conductivity and chloride concentrations were moderately elevated at most stations. The values observed, however, are not considered harmful to aquatic biota.

Lower Kaministiquia River

Monitoring stations 1 to 6 (Figure 2) were established to assess water quality changes in the Kaministiquia River attributable to municipal and industrial discharges. Station 1 upstream of these discharges is used to obtain water quality data for the uncontaminated portion of the river. In 1976, sampling for selected water quality parameters was conducted monthly (Table 2). As ice conditions prevented complete sampling at sites 2 and 6, caution must be exercised in comparing results from these two locations with values from other sites. It should also be recognized

that waters from Lake Superior underlying the Kaministiquia River as far upstream as the turning basin may substantially reduce the concentrations of discharged contaminants during spring and fall periods when thermal conditions favour mixing of these waters.

The main contributors of pollutants are the Great Lakes Paper Company Limited, Industrial Grain Products Limited, and municipal sewage. Analysis of data indicates that effluents from these sources have collectively caused severe ecological changes. Major problems associated with these waters include dissolved oxygen depressions, high bacterial counts and elevated phosphorus concentrations.

Heavy loadings of organic waste (measured as BOD_5), are apparent when BOD_5 values recorded downstream of Highway 61 are compared with values at the control site (station 1). Stations 2, 3 and 4 had BOD_5 values of 15.4, 13.5 and 10.1 mg/l, respectively; these levels are at least five times the concentration at the control site. As a result of organic loading, dissolved oxygen levels are depressed and in summer, values at many sites frequently fall below 5.0 mg/l, the minimum level considered necessary to sustain indigenous game fish.

Serious bacterial contamination at stations downstream of the control site renders waters unfit for domestic use and limits recreational pursuits. Total coliform, faecal coliform, and faecal streptococci counts at these stations are almost always above the Ministry of the Environment criteria of 1,000, 100, and 20 counts/100 ml, respectively -- the maximum limits recommended for bathing and other water-contact activities. Raw wastes from municipal sewers, which are partially responsible for these elevated bacterial levels, are expected to be diverted to the expanded sewage treatment plant and treatment for the remaining untreated domestic wastes from The Great Lakes Paper Company Ltd. will be provided by the Company in 1978.

Of the nutrient parameters, phosphorus warrants the most concern. Phosphorus concentrations at stations 2 to 7 are approximately twice the level recorded at the control site (.027 mg/l). Because phosphorus is considered the most important nutrient in these waters, the elevated phosphorus levels have probably stimulated growth of aquatic life, in the Kaministiquia River, and in the associated near shore waters of Thunder Bay. Natural phosphorus values in Thunder Bay waters are approximately 0.01 mg/l.

Dredging and discharges of suspended solids have substantially altered the populations and diversity of bottom-dwelling organisms. The results for 1976 indicate moderately elevated concentrations of suspended solids at stations affected by industrial and municipal effluent. Despite the increased suspended solids concentrations, turbidity values at stations 3 to 7 are nearly the same or less than the control site value of 8.5 F.T.U. (Formazin Turbidity Units). Chloride and conductivity values, though increased at sites below the control station, would have little, if any, effect on biota.

There is a noticeable aesthetic impairment of the Lower Kaministiquia River: generally, the waters are discoloured and malodourous and occasionally covered by small oil slicks.

Other Rivers

The Neebing, McIntyre and Current Rivers, and McVicar's Creek (Figure 2) were regularly monitored in 1976, primarily to ascertain urban effect and the loading of pollutants to Lake Superior. Control sites on the rivers were established to determine effects of urban development on these streams. Samples were collected for eleven months and mean results are presented in Table 3. Very serious impairment of waters monitored near the mouth of the McIntyre River (station 18) is apparent. Also evident is minor contamination of the lower Neebing River (station 20).

The discharge from a sewage treatment plant into the McIntyre River upstream from station 18 is primarily responsible for the gross deterioration in water quality of this river. Water quality at station 17, the control site, was generally very good. Large loadings of oxygen-consuming organic wastes are apparent when a mean BOD_5 value of 31.8 mg/l at station 18 is compared to the control site concentration of 0.9 mg/l. Most of the time, dissolved oxygen concentrations in the McIntyre River are depressed below 5.0 mg/l, the level necessary to sustain indigenous game fish and other desirable aquatic life. The extremely high nutrient concentrations at station 18, increased aquatic growth in the vicinity of the McIntyre River mouth. Total phosphorus and total kjeldahl levels were respectively, at least 20 and 30 times the control values. Also, one of the nutrient parameters, free ammonia, had concentrations at levels deleterious to fish populations.

Microbiological counts for total coliform, faecal coliform and faecal streptococci were 84,700, 917, and 2,610, respectively; these levels are far in excess of the Ministry of the Environment criteria for swimming, and public surface water supplies.

Substantial loadings of suspended solids have increased turbidity values 350% in the river below the sewage treatment plant. Dissolved wastes entering the river have raised the conductivity value from 284 to 385 μmhos/cm and were partially responsible for water discolouration. Waste loadings have reduced the river's aesthetic value.

Similarly, the Neebing River is contaminated by municipal discharges, but to a much lesser degree. During periods of prolonged rainfall, mixed storm water and sewage is bypassed into the last 3 km (kilometres) of the stream. With the expected diversion of all municipal waste to the expanded sewage treatment plant, substantial improvement in the quality of the Neebing and McIntyre Rivers is expected.

With the exception of certain bacterial counts, parameter values recorded at the Current River mouth showed little change from natural levels observed at the control site (station 14). At station 15, the geometric mean of 29 for faecal streptococci exceeded the Ministry of the Environment recommended maximum of 20/100 ml for body contact sports. Much higher results were observed in the summer months when conditions for bacterial populations are optimum (range 17-236). These 1976 values are elevated when compared to those of previous years. The reason for this is uncertain, but may be the result of the unusually low flow in the river. Other testings at several upstream locations remote from population and substantial human activity also revealed high counts of faecal streptococci; furthermore, counts for faecal coliforms and total coliforms showed that there was no problem arising from human or animal faecal contamination. Thus, despite the fact that faecal streptococci results apparently violate Ministry criteria, it is concluded from other evidence that waters in the Current River are acceptable for swimming. The reliability of the numerical criterion for faecal stroptococci as an indication of suitability for body contact recreation is questionable and the criteria are currently under review.

Samples collected at the mouth of McVicar Creek contained elevated levels of suspended solids, turbidity, and bacteria. The unusually high values of suspended solids and turbidity are likely caused by storm-water discharge from adjacent subdivisions. Although the geometric means for the 1976 microbiological counts are generally low, faecal streptococci counts in June, July and August exceeded the Ministry of the Environment criterion for swimming.

DRYDEN

For many years, the Wabigoon River, downstream of Dryden, has been one of the most severely polluted rivers in Ontario. Available information does not suggest there has been any substantial improvement in water quality since monitoring started in 1969.

Water quality monitoring stations 21 and 22 were established on the Wabigoon River at Dryden (Figure 3) to assess changes in water quality attributable to the operations of Reed Limited. In 1976, water sampling was conducted for selected water quality parameters in all months except January. Analysis of data (Table 4) from the two stations indicates that water quality is grossly deteriorated by the mill discharge. During low flow conditions, this discharge comprises over 25% of the flow of the Wabigoon River directly below the mill.

Generally, data obtained from samples collected at the control site (station 21) are indicative of good water quality. Although microbiological samples were not collected in 1976, data from 1972 to 1975 show bacteriological conditions similar to other uncontaminated waters in northwestern Ontario. However, an intensive survey of the Wabigoon River in the latter part of 1976 revealed that the geometric mean faecal streptococci count at this site was slightly above the Ministry of the Environment criterion for water contact recreational use. Regular microbiological monitoring was resumed in 1977.

Of the many environmental problems associated with the Wabigoon River below Reed Limited, low dissolved oxygen concentrations, high bacteria and suspended solids levels, poor aesthetic conditions and past mercury discharges are among the major concerns. All are associated with the heavy loadings of pulp and paper mill wastes from Reed Limited.

The heavy loading of organic wastes is evident from a comparison of the 1976 BOD_5 concentration for the station upstream of Reed Limited (1.0 mg/l) with the downstream value (23.8 mg/l). Oxidation of these organic wastes produces oxygen deficits in the river as far as 65 km (kilometres) downstream. The organic loading does not have an immediate effect on dissolved oxygen levels and the mean dissolved oxygen concentration for the station downstream of Reed Ltd. is 10.3 mg/l. However, much of the Wabigoon River below Dryden has summer dissolved oxygen values of less than 5.0 mg/l, the level considered necessary to sustain indigenous game fish populations.

Microbiological data from routine monitoring in 1972-75 and data from an intensive survey in 1976 indicated severe contamination in waters monitored at station 22. Here, bacterial counts for total coliform and faecal streptococci substantially exceed the Ministry of the Environment criteria for swimming, and other water-contact sports. Other factors notwithstanding, these high bacteria populations also preclude the use of the Wabigoon River for domestic use, as microbiological results are well in excess of Ministry of the Environment criteria for public surface water supplies.

Aesthetically, the river and its bank are considered objectionable for over 24 km downstream of Dryden. Organic wastes emanating from Reed Limited have raised suspended solids concentrations in the river from the control site value of 5.3 mg/l to 30.3 mg/l at station 22. Increased suspended solids also adversely affects water clarity as evidenced by a fourfold increase in turbidity levels. The suspended particulate consisting mostly of wood fibre is prone to forming floating sludge mats, which are often carried long distances downstream.

During the summer, exposed river banks are covered with pulp and paper wastes deposited during high flows. Portions of the river bottom are covered with these wastes for 65 kilometres downstream, resulting in major changes in the diversity and number of bottom dwelling organisms. At station 22, waters are malodourous, discoloured and exhibit a high potential to foam. In some sections of the river, the surface water is constantly disturbed as gases produced in the sediment reach the top of the water column.

At the downstream station, the following increases in the concentrations of nutrient parameters are noted - total phosphorus +106%, soluble phosphorus +107%, total kjeldahl +45%, nitrite +37%, nitrate +8%, free ammonia +20%. These nutrients promote generally undesirable biological growth in a major portion of the Wabigoon River system. Clay Lake experiences severe algal blooms lowering its recreational and aesthetic value.

Phenolic compounds are also discharged into the Wabigoon River by Reed Limited. Phenolic concentrations observed for the downstream site (139 µg/l) were considerably higher than for the control station (2 µg/l). Phenolic concentrations found at the downstream site are capable of taste and odour tainting of river water, other mill waste notwithstanding.

Past mercury discharges into the Wabigoon River at Dryden have raised mercury levels in the flesh of most game fish found in the lower Wabigoon-English River system above 0.5 mg/l, the upper limit established by the Canadian Food and Drug Directorate for freshwater animal products offered for sale in Canada. Although mercury has not been used in Reed Limited's processes for the production of chlorine since November, 1975, an increase in mercury concentration in water is apparent when the downstream value of $< .08$ µg/l is compared with the control result of $< .06$ µg/l. Resuspension of sediment contaminated from past mercury discharges is believed to be the principal cause of this increased level of mercury. Loss of mercury from previously contaminated

equipment could also be a contributing factor. Regardless of the source, the additional mercury in the water column will lengthen the time necessary to provide conditions in the Wabigoon River system which yield fish acceptable for human consumption.

Variations in other parameters between sites are not considered to be of significant concern.

In mid-1976, both during and after a mill shutdown, an intensive sampling of the Wabigoon River between Dryden and the outlet of Clay Lake was conducted to determine the impact of the change in the industrial discharge on downstream water quality. When the mill ceased operations, major reductions were observed in the concentrations of most parameters, resulting in a dramatic improvement in water quality. Due to previously deposited organic wastes on the river bottom which continued to remove dissolved oxygen from overlying waters, dissolved oxygen concentrations remained below 5.0 mg/l in parts of the river.

In order to improve water quality in the Wabigoon River, the Company will have to improve its effluent through abatement measures. In addition to in-plant waste-water controls or treatment, such as a spill collection system and condensate stripping, external treatment measures will be included. When these changes are implemented, a marked reduction in BOD_5 and suspended solids will occur. The effluent will also be considerably less toxic to fish, and components contributing to taste and odour tainting of waters will be substantially reduced.

KENORA

Water quality monitoring stations 23 and 24 (Figure 4), were established on the Winnipeg River at Kenora, primarily to assess changes in water quality attributable to the effluent from the Ontario-Minnesota Pulp and Paper Company. In addition to serving

as a control site for the effects of mill operations, on the river, station 23 also monitors surface water characteristics of Safety Bay in Lake of the Woods. In 1976, water sampling was conducted for selected water quality parameters in all months except January, May and December.

Data in Table 5 reveal good water quality at the outlet of Lake of the Woods, with the exception of elevated bacteria counts. The high total coliform count (geometric mean 15,400 per 100 ml) is well above the Ministry of the Environment criterion (1,000 per 100 ml), the maximum level deemed suitable for swimming, and other water-contact sports. The bacteria populations also exceed the Ministry of the Environment criteria for public surface water supplies. This condition was previously noted in a report by the Ontario Water Resources Commission, which stated that waters in the Kenora vicinity are unfit for domestic and recreational use. Partially treated sewage entering Safety Bay from residential areas and cottages surrounding this portion of Lake of the Woods has caused these elevated bacteria levels. Sewer extensions to the unserviced areas of the Town of Kenora will be provided in the next few years, which should substantially improve bacteriological quality in affected waters. Elevated microbiological populations which could limit recreational use are absent from other areas in the northern part of Lake of the Woods.

Impairment of the Winnipeg River is primarily attributable to the effluent from operations at the Ontario-Minnesota Pulp and Paper Company Limited. With the exception of phosphorus, effects of loadings from the municipal sewage treatment plant are very small in comparison to mill discharges. Fortunately, because of large flows in the Winnipeg River, water quality is considerably better than for most other streams in northern Ontario receiving effluents from the pulp and paper industry. In comparison with the control site, adverse water quality characteristics at station 24 include elevated bacteria counts, depressed dissolved oxygen values and decreased water clarity.

Suspended solids concentrations, which increased from 4.0 mg/l at the control site to 5.6 mg/l at station 24, raised the turbidity values by approximately 25%. The additional suspended particulate not only results in some loss in aesthetic value but also places stress on the aquatic ecosystem. Previous loadings to the river, of suspended wood fibres and chips, continue to be a major problem. During low flows, organic deposits of fibre and bark are observed immediately downstream of the mill. The river bottom is covered with similar organic wastes for several kilometres downstream, causing unfavourable conditions for most bottom-dwelling organisms. Improved effluent treatment has significantly reduced such organic waste loadings; however, because of the previously deposited materials' strong resistance to natural degradation processes, it may take decades before substantial ecological improvement on the river bottom is evident.

Downstream of the pulp and paper mill, microbiological results exceed the Ministry's criteria for public surface water supplies, and also for bathing and other water-contact sports. The quantitative effect of effluent from the mill on bacteria counts in the Winnipeg River is uncertain as elevated bacteria counts are also present in waters at the control site. Since natural factors favour much higher numbers of bacteria in summer than in winter, mean counts shown in Table 5 are lower than values encountered in peak recreational periods.

An increase in oxygen-consuming wastes is evident when the BOD_5 concentration of 5.4 mg/l is compared with the control site value of 1.5 mg/l. Although organic waste loadings resulted in a dissolved oxygen depression of 1.5 mg/l at the downstream site, dissolved oxygen levels were higher year round than 5.0 mg/l, the minimum level necessary to support indigenous game fish populations. Dissolved oxygen values at the downstream site ranged from 6.0 to 12.0 mg/l.

Except for total phosphorus, any increases at the downstream site in other parameters found in Table 5, are considered to have only marginal effects on river biota. Phosphorus loadings to the river by the municipal sewage treatment plant are greater than contributions by the Ontario-Minnesota Pulp and Paper Company Limited. Increased total phosphorus concentrations (+25%) below the mill and treatment plant, will probably increase biological growth, as in these waters, phosphorus is considered the limiting nutrient.

RAINY RIVER SYSTEM

Eight sites on Rainy River, (stations 25 to 32 in Figure 5) between Rainy Lake and Lake of the Woods were monitored to assess water quality changes downstream of two pulp and paper companies.

Effluents from the Ontario-Minnesota Pulp and Paper Company Limited pulp and paper mill in Fort Frances and the Boise Cascade Corporation pulp and paper and insulite mills in International Falls, Minnesota are primarily responsible for adverse changes in water quality.

Although minor in comparison with the effects of effluent from the mills, treated sewage discharges to the river by adjacent municipalities also contribute to water quality impairment, as does runoff from agricultural activities. Rainy River, by virtue of its large diluting capacity, compares favourably with some other northern Ontario rivers receiving similar waste loads; however, serious impairment still exists. Contamination of this river has, unfortunately, undermined its excellent potential for recreational development. Due to the high waste loading, its recreational use is usually limited to the last 30 km before it enters Lake of the Woods.

During 1976, sites were sampled for selected water quality parameters for a minimum of six months with the exceptions of stations 27 and 28 (Table 6). Caution must be exercised in interpreting parameter variations among stations, as most sites were sampled with a different frequency. Additionally, increases in many parameters downstream of station 28 may not necessarily be the result of industrial or municipal waste. Due to regional geology, most tributaries entering the Rainy River (i.e., Big Fork River) have much higher nutrient, turbidity and conductivity values than Rainy River itself. Resulting changes in water chemistry in Rainy River downstream of station 28 are primarily dependent upon tributary flows.

Analysis of data obtained from the control site (station 25) indicates that waters above the mills are of excellent quality; parameter values were typical of uncontaminated waters in Northwestern Ontario. Downstream of these mills, however, adverse changes in water quality are evident. Problems associated with the river include elevated microbiological populations, suspended solids concentrations and nutrient levels.

Historically, most of the river downstream of Fort Frances has had extremely high bacteria counts. In 1976, total coliform counts, exceeding the Ministry of the Environment criterion of 1,000/100 ml for swimming, and other water-contact sports, were recorded at the first three stations downstream of Fort Frances. Results of monitoring conducted from 1972 to 1975 indicate monitoring sites 29 to 32 also had bacteriological results exceeding criteria. Microbiological results from 1972 to 1975 also exceed the Ministry of the Environment criteria for public surface water supplies at sites 25 to 29.

In the upper reaches, deposits of wood chips and fibres, emanating from the mills can be observed along the river during low flows, thus decreasing its aesthetic value. In addition to raising turbidity values, the suspended wood wastes, after settling, have produced major changes in the diversity and number of bottom-dwelling organisms. Pulp wastes also form floating fibre mats which are present for many miles downstream. Suspended fibre also provides a medium for rapid growth of bacteria.

Increases in the nutrient parameters, particularly total phosphorus and total kjeldahl nitrogen, are evident downstream of Fort Frances at stations 26, 27 and 28. Values for these nutrients are usually two to three times greater than concentrations observed at the control site. Although these elevated levels may have serious implications for the productivity of Rainy River itself, the effects on the trophic status of Lake of the Woods may warrant further concern.

Because much of the mill wastes is oxidized in waters upstream of station 26, BOD_5 values determined downstream of Fort Frances are low. Organic waste discharged by the two pulp and paper companies results in oxygen depressions in most of the river; however, dissolved oxygen levels at all stations are above 5.0 mg/l, the level considered necessary to support indigenous game fish and other desirable aquatic life. Although fish are found throughout the river, some fish are not considered fit for consumption. The results of questionnaires completed by local residents indicated that some fish caught downstream of the mills have objectionable taste. Fish tainting is not uncommon when fish are obtained from waters receiving pulp and paper wastes. Pulp and paper mill waste contains a wide variety of phenolic compounds, some of which have a demonstrated ability to cause taste and odour tainting of water. In comparison with the control station, phenolic concentrations are elevated at downstream stations on the river. However, no direct relationship between effluents from these mills and the tainted fish has been established.

Mercury concentrations in the river are invariably below the detection limit (0.05 µg/l), as are most surface waters in north-western Ontario.

In order to review water quality and abatement programs, semi-annual meetings are conducted by the International Joint Commission under the Rainy River Water Pollution Board.

RED LAKE AREA

Sampling stations 33 to 38 were selected primarily to monitor waters receiving wastes from mining operations (Figure 6). Since stations were sampled for selected water quality parameters on an irregular frequency, caution must be exercised when comparing parameter values for different sites. Results, (Table 7), generally indicate good water quality with respect to public health and aquatic biota, except for small watersheds affected by mining operations.

Substantially degraded waters are found in Balmer and Snib Creek systems. In Balmer Creek, contaminants introduced by Dickenson Mines Ltd. and Campbell Red Lake Gold Mines Limited via Balmer Lake are mainly responsible for these adverse affects. Most contaminant concentrations were highest at the Balmer Lake outlet site (station 35). Natural stream purification processes reduce levels of many of these parameters at the next site downstream.

Monitoring results indicate that levels of arsenic, manganese and cyanide at Balmer Creek (stations 35 and 36) are in excess of Ministry of the Environment public surface water supply criteria of 0.05, 0.05 and 0.2 mg/l, respectively. Although 1976 microbiological results were low, bacterial counts at station 36 were higher in former years than the Ministry of the Environment recommended maxima for water-oriented body-contact sports. The Balmertown septic tank system is believed to be responsible for elevating microbiological populations. A proposed new sewage treatment plant should rectify the problem.

Elevated conductivity and chloride values probably have minor effects on the stream ecology. Concentrations of lead and phenolic compounds are usually low; these parameters have levels typical of most surface waters in northwestern Ontario. Elevated levels of copper, arsenic and cyanide are harmful to many forms of aquatic life and, undoubtedly, the presence of these contaminants in Balmer Creek have seriously altered the number and diversity of stream biota.

Very high concentrations of the nutrient parameters - total kjeldahl, ammonia, nitrite, nitrate, total phosphorus, and soluble phosphorus - have stimulated generally undesirable biological growth in Balmer Creek. Downstream of the sewage inflow, increased algae growth was evident. Since concentrations of organic wastes, measured as BOD_5 were low, dissolved oxygen concentrations were well above levels necessary to support desirable aquatic life.

Mercury concentrations are elevated in comparison to the levels found in most surface waters. Although these values in water pose no direct threat to public health, an indirect danger may exist. Mercury is accumulative in many organisms, and fish or other organisms taken from mercury-contaminated waters may pose a threat to human health if they are used for food. In 1977, fish from the Red Lake area were collected and are being analyzed for mercury, to determine whether or not they are suitable for consumption.

Other parameters in Table 8 have values considered not adverse to public health or aquatic biota.

Data obtained on the Chukuni River downstream from Balmer Creek, show that these waters are fit for recreational use and, when treated, domestic use as well. The large diluting capacity of the Chukuni River substantially reduces contaminant levels observed at the mouth of the Balmer Creek.

Snib Creek waters monitored at station 38 are contaminated as a result of the former operation of Madsen Red Lake Gold Mines Limited. Water quality at the Snib Creek site is comparable to that of Balmer Creek at station 36, with the exception of phosphorus, arsenic and cyanide concentrations. These contaminants occurred in lower concentrations in Snib Creek than in Balmer Creek, but arsenic and manganese values exceed Ministry of the Environment criteria for public surface water supplies. Although operations at Madsen-Red Lake Gold Mines Limited ceased in mid-1976, data for the latter part of the year reveal elevated concentrations of many parameters; consequently, sampling of this site will continue.

Waters monitored in Bruce Channel and Howey Bay (stations 33 and 34) are of very good quality, and are acceptable for domestic and recreational use.

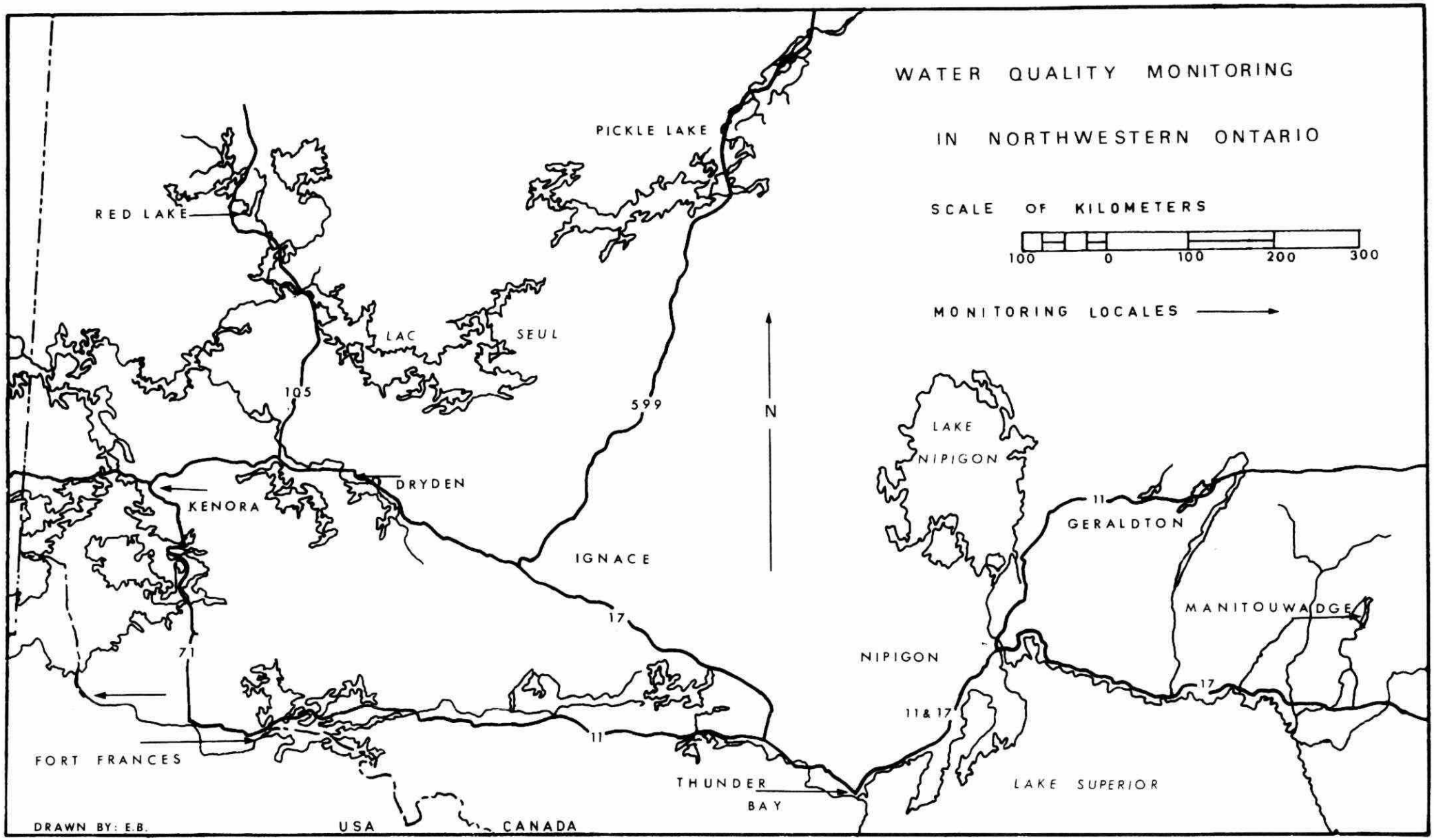

FIGURE I - WATER QUALITY MONITORING LOCALES

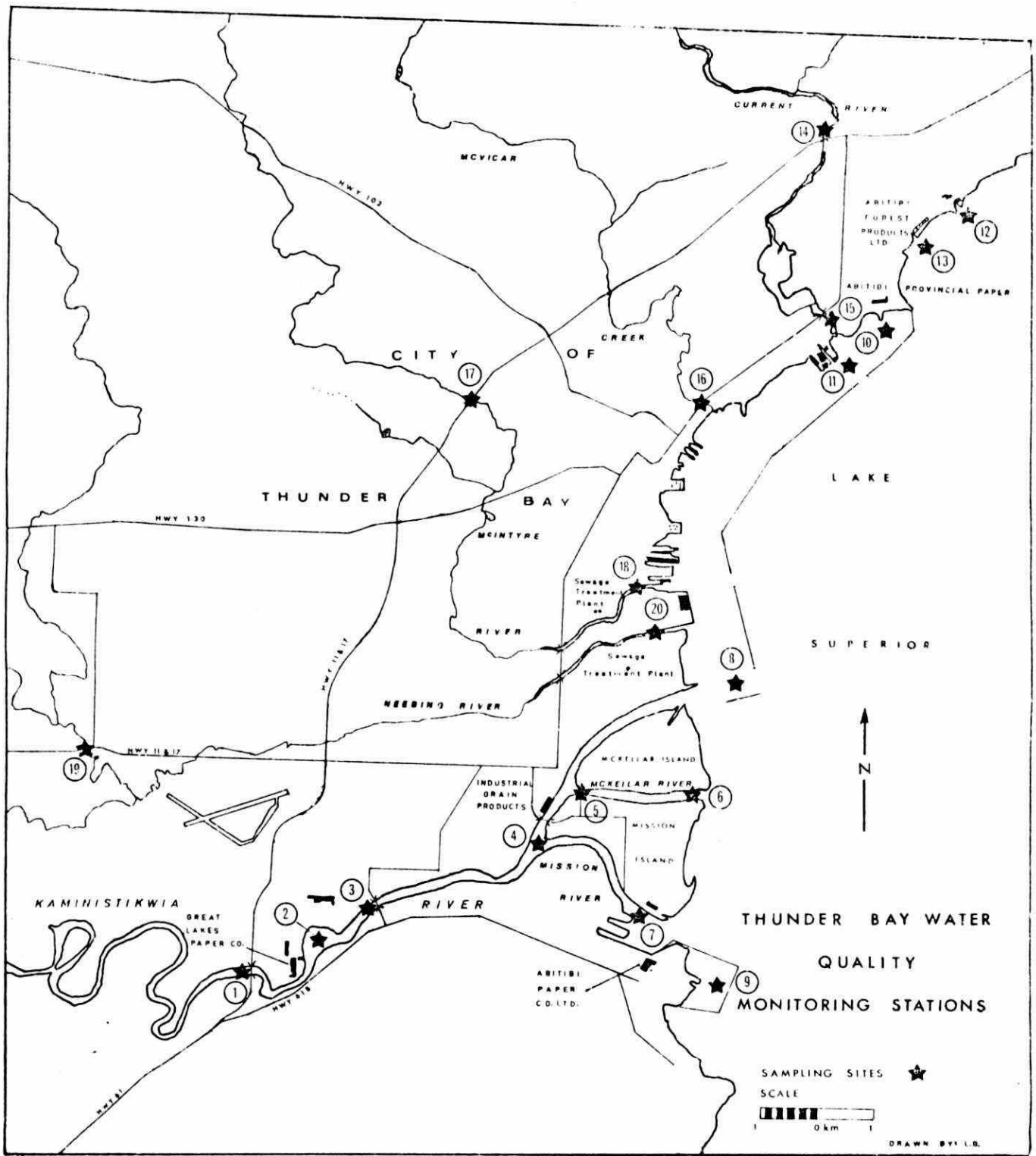

FIGURE 2: THUNDER BAY WATER QUALITY MONITORING STATIONS

Table 1: Average values for selected water quality parameters, Lake Superior, 1976

Parameters[a]	Location[b] 8	9	10	11	12	13
BOD_5	1.4	1.7	7.0	2.4	2.5	5.3
Dissolved oxygen	10.6	7.4	8.3	9.4	10.2	9.8
Temperature (^oC)	11.8	13.5	12.5	12.4	11.3	12.7
Suspended solids	9.0	5.5	7.5	5.0	NA[c]	NA
Conductivity (μmhos/cm)	106	119	112	101	105	115
Turbidity (F.T.U.)	3.1	3.1	10.4	3.2	2.3	4.0
Free ammonia	.03	.01	.02	.01	.02	.02
Total kjeldahl	.32	.40	.42	.22	.24	.25
Nitrite	.004	.004	.006	.004	.004	.003
Nitrate	.100	.032	.038	.067	.059	.092

[a] All values in *mg/ℓ* except as specified.

[b] Location - see also figure 2.

8 Near Kaministiquia River mouth
9 Near Abitibi (Fort William Division)
10 Near Abitibi (Provincial Paper Division)
11 Inside Lakehead Harbour, eastern gap
12 Near Abitibi (Thunder Bay Division)
13 0.5 km west of station 12

[c] Data not available.

Table 1: (Continued)

Parameters	Location					
	8	9	10	11	12	13
Total phosphorus	.029	.022	.023	.010	.018	.018
Soluble phosphorus	.005	.003	.010	.002	.005	.004
Chloride	3.0	3.7	2.7	1.5	2.0	2.3
Bacteria [d]						
Total coliform (x 10^3)	2.39	9.57	5.40	.712	.721	.254
Faecal coliform	8.5	12	20	6	5	4
Faecal streptococci	12	4	17	4	9	5
No. of months sampled	6	6	6	6	6	6

[d] Counts per 100 ml (Geometric mean).

Table 2: Average values for selected water quality parameters, Lower Kaministiquia River, 1976

Parameters[a]	Location[b] 1	2	3	4	5	6	7
BOD_5	1.9	15.4	13.5	10.1	4.3	3.5	6.8
Dissolved oxygen	11.7	7.9	10.6	8.2	10.3	6.7	8.8
Temperature (^oC)	5.7	15.4	6.3	5.9	6.3	11.6	6.8
Suspended solids	3.9	5.0	5.8	9.8	6.2	7.6	8.4
Conductivity (μmhos/cm)	81	147	148	128	110	114	116
Turbidity (F.T.U.)	8.5	15.1	8.8	6.7	7.1	4.3	5.0
Free ammonia	.05	.05	.05	.03	.07	.02	.03
Total kjeldahl	.56	.68	.59	.62	.62	.49	.56
Nitrite	.006	.011	.011	.010	.007	.005	.009
Nitrate	.035	.016	.016	.014	.045	.051	.016
Total phosphorus	.027	.060	.042	.049	.061	.044	.043
Soluble phosphorus	.006	.012	.012	.009	.012	.006	.009

[a] All values in mg/ℓ except as specified.

[b] Location - see also figure 2.

1 At Hwy. #61
2 Middle of turning basin
3 At Hwy. #61B
4 Upstream Mission and McKellar Rivers
5 McKellar River at 104th Avenue
6 McKellar River near mouth
7 Mission River near mouth

Table 2: (Continued)

Parameters	Location						
	1	2	3	4	5	6	7
Chloride	1.2	12.5	14.1	10.4	5.3	5.4	7.9
Bacteria[C]							
Total coliform (x 10^3)	.176	8.76	4.63	6.39	4.63	1.27	3.89
Faecal coliform	5	128	199	200	133	45	153
Faecal streptococci	9	84	156	202	218	43	255
No. of months sampled	12	8	12	12	12	10	12

[C] Counts per 100 ml (Geometric mean).

Table 3: Average values for selected water quality parameters, Thunder Bay Rivers, 1976

Parameters[a]	Location[b] 14	15	16	17	18	19	20
BOD_5	1.0	1.0	1.3	0.9	31.8	1.1	2.0
Dissolved oxygen	11.5	11.3	11.1	10.3	4.3	10.9	11.0
Temperature (^oC)	10.9	9.9	8.7	10.2	8.2	8.6	8.3
Suspended solids	1.8	2.0	29.7	2.0	26.1	2.7	7.3
Conductivity (μmhos/cm)	79	89	342	224	385	282	347
Turbidity (F.T.U.)	1.2	2.1	13.3	5.8	21.9	4.7	11.2
Free ammonia	.03	.06	.08	.03	7.3	.04	.16
Total kjeldahl	.36	.43	.53	.43	14.3	.53	.83
Nitrite	.004	.005	.009	.004	.019	.005	.009
Nitrate	.030	.033	.290	.059	.045	.054	.069

[a] All values in *mg/ℓ* except as specified.

[b] Location - see also figure 2.

14 Current River at Highway 17
15 Current River near mouth
16 McVicar Creek near mouth
17 McIntyre River at Highway 17
18 McIntyre River near mouth
19 Neebing River at Highway 17
20 Neebing River near mouth

Table 3: (Continued)

Parameters	Location						
	14	15	16	17	18	19	20
Total phosphorus	.010	.012	.050	.013	2.72	.040	.052
Soluble phosphorus	.003	.003	.008	.004	1.04	.004	.004
Bacteria[c]							
Total coliform (x 10^3)	.015	.032	.366	.155	84.7	.176	.483
Faecal coliform	4	6	19	6	917	8	21
Faecal streptococci	10	29	23	3	2610	15	35
No. of months sampled	12	11	11	11	8	11	10

[c] Counts per 100 ml. (Geometric mean).

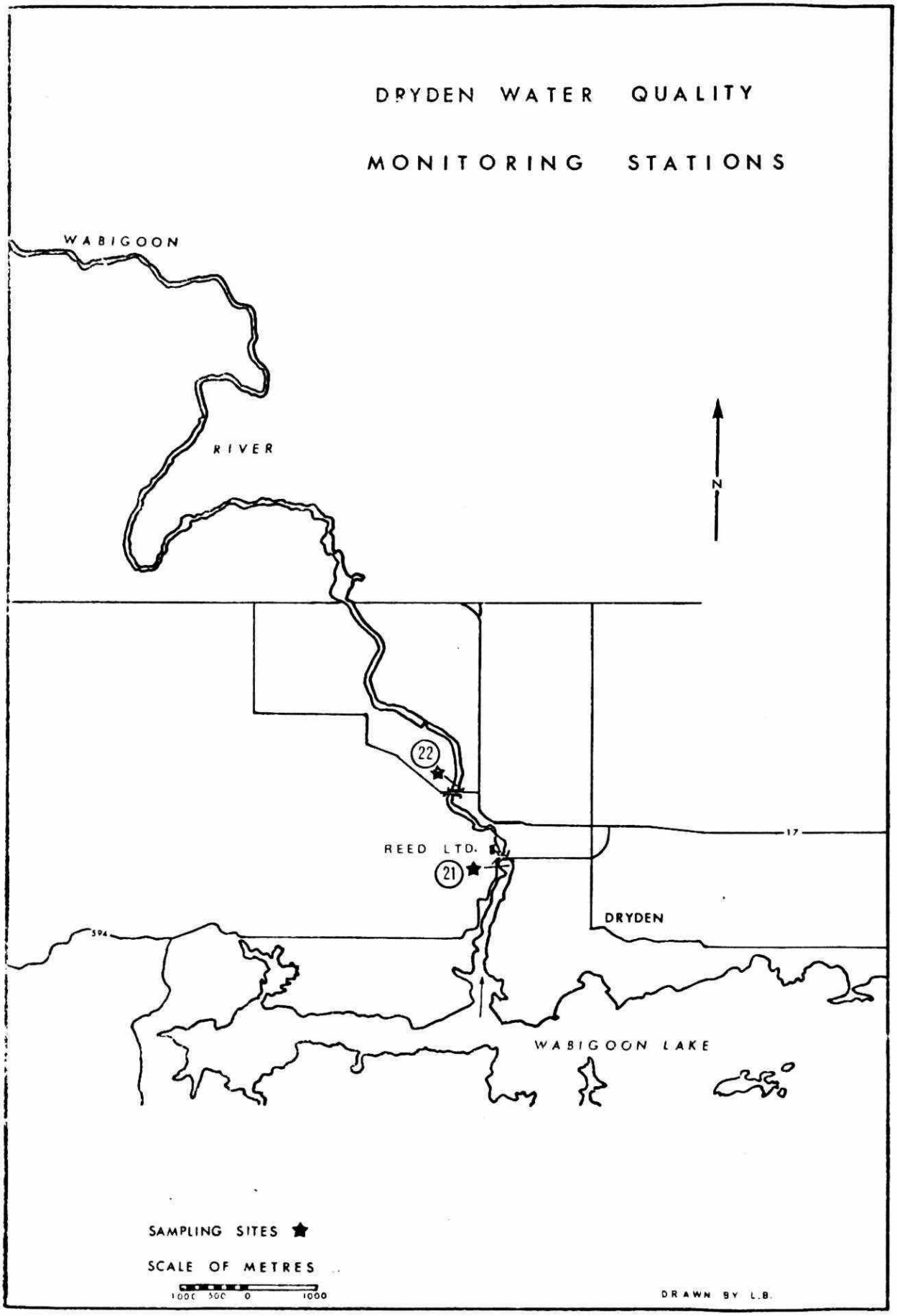

FIGURE 3: DRYDEN WATER QUALITY MONITORING STATIONS

Table 4: Average values for selected water quality parameters, Wabigoon River at Dryden, 1976

Parameters[a]	Location[b] Upstream Reed Ltd. (21)	Downstream Reed Ltd. (22)
BOD_5	1.0	23.8
Dissolved oxygen	13.0	10.3
Temperature (^oC)	6.1	8.3
Suspended solids	5.3	27.8
Conductivity (µmhos/cm)	105	229
Turbidity (F.T.U.)	14.3	21.9
Free ammonia	.05	.06
Total kjeldahl	.44	.64
Nitrite	.008	.011
Nitrate	.013	.014
Total phosphorus	.036	.074
Soluble phosphorus	.015	.031
Chloride	< 1.1	24.2
Phenols (µg/ℓ)	2.0	139.0
Mercury (µg/ℓ)	< .06	< .08
Number of months sampled	11	11

[a] All values in mg/ℓ except as specified.

[b] See also figure 3.

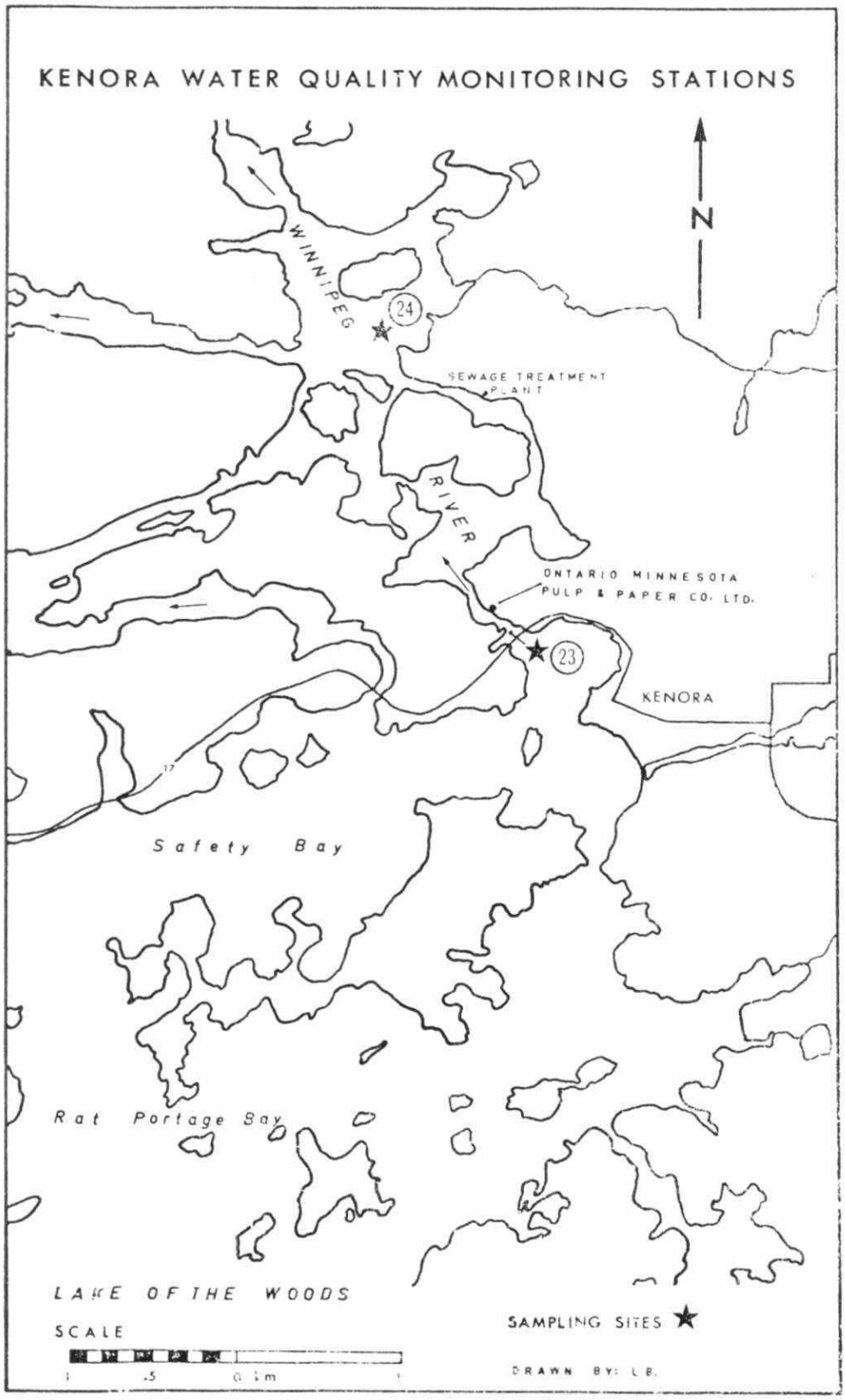

FIGURE 4: KENORA WATER QUALITY MONITORING STATIONS

Table 5: Average values for selected water quality parameters, Winnipeg River at Kenora, 1976

Parameters[a]	Location[b] Upstream of Ontario-Minnesota Pulp & Paper Co. Ltd. (23)	Downstream of Ontario-Minnesota Pulp & Paper Co. Ltd. (24)
BOD_5	1.6	5.4
Dissolved oxygen	11.1	9.6
Temperature (^oC)	12.3	11.1
Suspended solids	4.0	5.6
Conductivity (μmhos/cm)	110	122
Turbidity (F.T.U.)	3.2	4.0
Free ammonia	.03	.02
Total kjeldahl	.60	.62
Nitrite	.004	.004
Nitrate	.026	.018
Total phosphorus	.028	.033
Soluble phosphorus	.008	.005
Chloride	< 2.0	2.4
Bacteria[c]		
Total coliform (x 10^3)	15.4	16.4
Faecal coliform	32	18
Faecal streptococci	8	43
No. of months sampled	9	9

[a] All values in *mg/ℓ* except as specified.

[b] See also figure 4.

[c] Counts per 100 ml (Geometric mean).

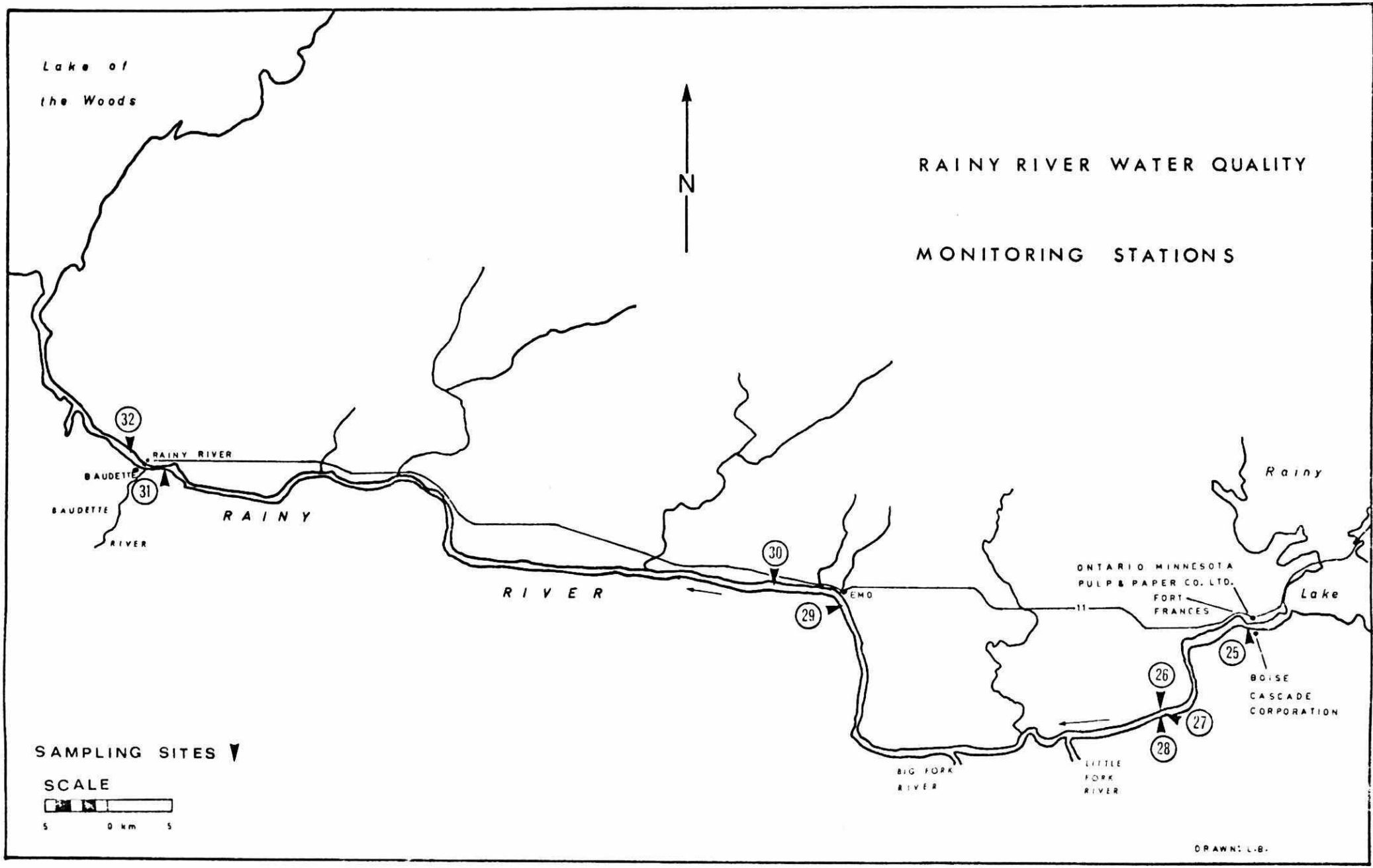

FIGURE 5: RAINY RIVER WATER QUALITY MONITORING STATIONS

Table 6: Average values for selected water quality parameters, Rainy River, 1976

Parameters[a]	Location[b] 25	26	27	28	29	30	31	32
BOD_5	1.1	1.3	1.3	1.7	1.6	1.8	2.3	1.4
Dissolved oxygen	10.1	9.6	8.5	8.5	9.6	9.1	9.9	9.8
Temperature (^{o}C)	16.8	14.0	20.1	20.1	17.7	17.5	18.0	14.6
Suspended solids	4.3	19.3	4.0	11.5	29.6	15.4	7.4	33.2
Conductivity (μmhos/cm)	52	72	67	73	91	96	93	91
Turbidity (F.T.U.)	1.7	6.1	4.2	5.7	13.6	6.9	4.8	11.4
Free ammonia	.02	.03	.02	.03	.03	.06	.03	.04
Total kjeldahl	.34	.69	.43	.53	.83	.82	.74	.63
Nitrite	.003	.004	.003	.003	.007	.007	.004	.005
Nitrate	.016	.022	.010	.010	.024	.045	.010	.016

[a] All values in *mg/ℓ* except as specified.

[b] Location - see also figure 5.

25 Toll bridge Fort Frances
26 Downstream Fort Frances, north
27 Downstream Fort Frances, centre
28 Downstream Fort Frances, south
29 Upstream Emo
30 Downstream Emo
31 Upstream Rainy River (Town)
32 Downstream Rainy River (Town)

Table 6: (Continued)

Parameters	Location							
	25	26	27	28	29	30	31	32
Total phosphorus	.017	.057	.037	.050	.082	.064	.051	.073
Soluble phosphorus	.004	.008	.008	.017	.023	.021	.010	.014
Chloride	1.0	2.2	3.0	2.5	2.9	3.9	4.1	3.3
Phenols (µg/ℓ)	5.3	12.8	17.0	9.5	6.9	14.6	6.0	10.0
Mercury (µg/ℓ)	< .05	< .05	< .05	NA [d]	< .05	< .05	< .05	< .05
Bacteria [c]								
Total coliform (x 10^3)	.031	1.02	19.7	10.8	.294	.264	.043	.374
Faecal coliform	3	17	177	65	4	11	2	24
Faecal streptococci	2	2	5	2	4	1	2	5
No. of months sampled	8	6	2	2	8	8	7	9

[c] Counts per 100 ml (Geometric mean).

[d] Data not available.

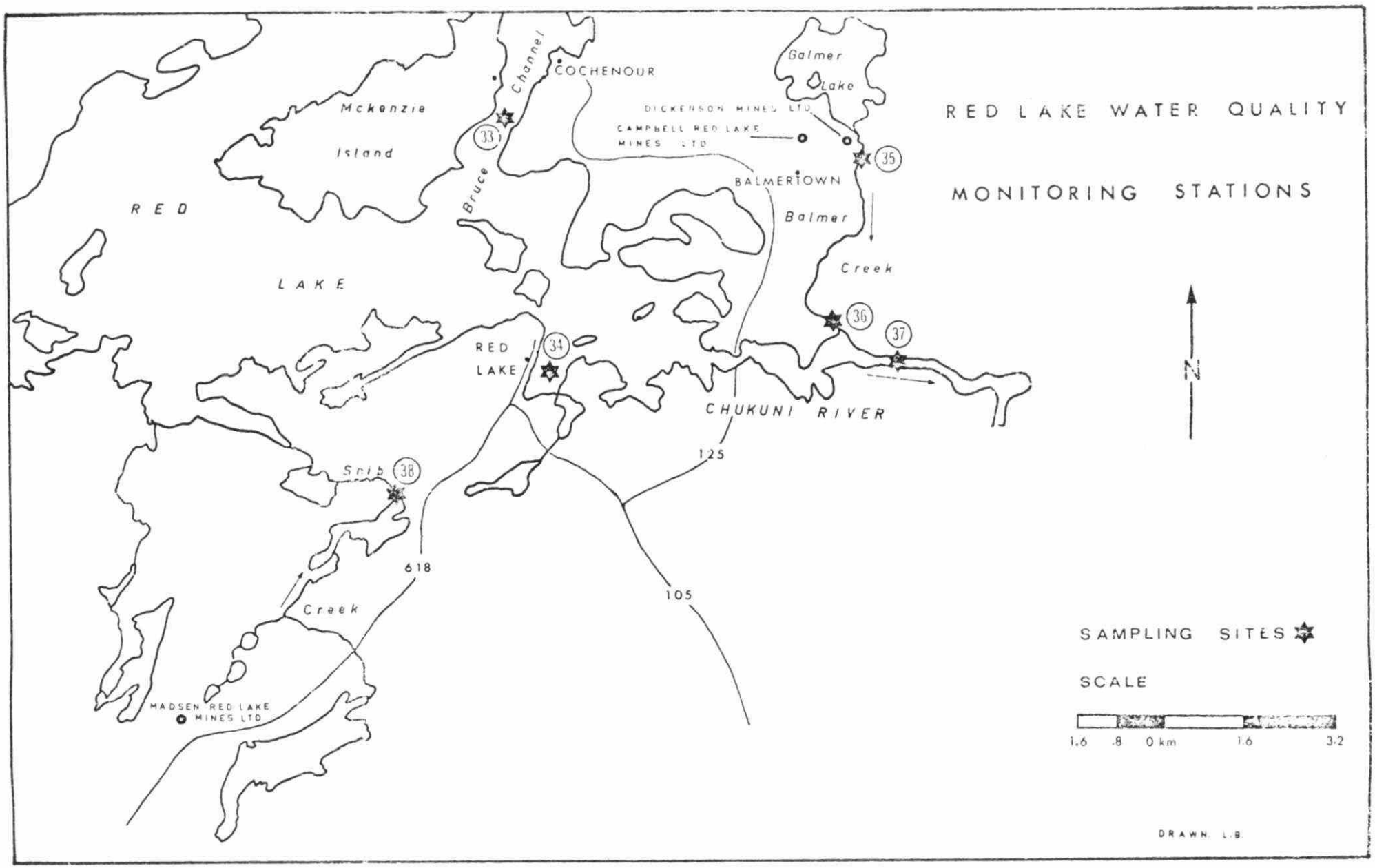

FIGURE 6: RED LAKE WATER QUALITY MONITORING STATIONS

Table 7: Average values for selected water quality parameters, Red Lake area, 1976

Parameters[a]	Location[b] 33	34	35	36	37	38
BOD_5	1.1	1.4	2.2	2.3	2.1	1.5
Dissolved oxygen	10.4	10.6	9.0	7.9	10.5	10.5
Temperature (^{o}C)	10.4	10.2	9.4	14.3	16.3	9.0
Suspended solids	NA[c]	NA	28.8	4.0	4.0	NA
Conductivity (μmhos/cm)	60	59	642	231	66	286
Turbidity (F.T.U.)	1.0	1.1	13.8	4.4	3.1	1.7
Free ammonia	.02	.03	.53	.10	.04	.19
Total kjeldahl	.46	.51	1.36	.88	.48	.91
Nitrite	.003	.003	.038	.017	.004	.021
Nitrate	.012	.011	1.07	.290	.020	.234
Total phosphorus	.017	.025	.163	.076	.027	.035
Soluble phosphorus	.006	.010	.140	.082	.014	.030

[a] All values in *mg/ℓ* except as specified.

[b] Location - see also figure 6.

33 Bruce Channel in Red Lake
34 Howey Bay in Red Lake
35 Balmer Creek at Balmer Lake outlet
36 Balmer Creek near Chukuni River
37 Chukuni River, downstream of Balmer Creek
38 Snib Creek at Snib Lake outlet

[c] Data not available.

Table 7: (Continued)

Parameters	Location					
	33	34	35	36	37	38
Chloride	< 1.0	< 1.1	81.3	16.5	< 1.5	42.4
Sulphate	15.5	5.8	NA	NA	NA	31.4
Manganese	< .006	NA	.280	NA	< .007	.169
Lead	< .017	< .016	< .016	.017	.018	< .015
Copper	< .005	< .010	.372	NA	.007	.099
Mercury (µg/ℓ)	< .055	< .088	< .082	< .060	< .060	< .055
Arsenic	< .018	< .016	.624	.335	.033	.098
Cyanide	NA	.01	.72	.49	.01	.01
Phenols (µg/ℓ)	4.5	2.5	< 3.2	3.8	< 3.7	5.6
Bacteria[d]						
Total coliform (x 10^3)	.002	.020	.044	.033	.016	.007
Faecal coliform	1	1	2	5	1	5
Faecal streptococci	2	1	5	3	4	4
Number of months sampled	5	7	4	2	2	7

[d] Counts per 100 ml (Geometric mean).